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"ROCK GLACIERS" OR CHRYSTOCRENES

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In the number of the *Journal of Geology* for June, 1910, there is an interesting article by Stephen R. Capps, Jr., on "Rock Glaciers in Alaska" which must be of especial interest to all those who have lived in Alaska or in the Yukon Territory, and more particularly to those who have lived in the city of Dawson, for these latter will at once recognize the similarity of the rockslides described and illustrated by Mr. Capps to "the Slide" on the face of Moosehide Mountain at the north end of the town of Dawson, since the Slide is one of the outstanding and ever-present features of the landscape to every resident of that northern city.

The city of Dawson is situated on a swampy alluvial flat on the east bank of the Yukon River, just below the confluence of the Klondike River. About a mile to the northeast of it Moosehide Mountain rises to a height of 2,000 feet or more above the city, a spur of the mountain extending down to the Yukon River, and terminating the Dawson flat toward the north.

The mountain is composed of massive basic eruptive rock or diabase largely altered to serpentine, and cut by numerous jointage planes which allow the rock to break readily into angular fragments. Over the larger portions of the surface of the mountain the rock has been weathered and decomposed to a considerable depth, and has broken down into sand or rock flour, so that the natural slopes are consequently gradual and gentle. But on the southwest side of the mountain, directly overlooking the town of Dawson, there is a steep scarp face of bare rock several hundred feet in height, at the foot of which a talus of broken rock-fragments extends outward and downward toward the river. This talus extends so far outward from the foot of the scarp, and its lower portion has such a relatively gentle slope, that it has somewhat the appearance of having broken away suddenly from the side of the mountain; and consequently the early

miners attributed to the Indians a tradition that many, many years ago it had so broken away, and had buried an Indian village beneath it.

But it is not necessary to invoke any sudden landslide to account for this bare cliff and the great pile of loose rock at its base, since fragments of rock are even now constantly falling from the face of the scarp and adding to the size of the hill of rock-fragments below it.

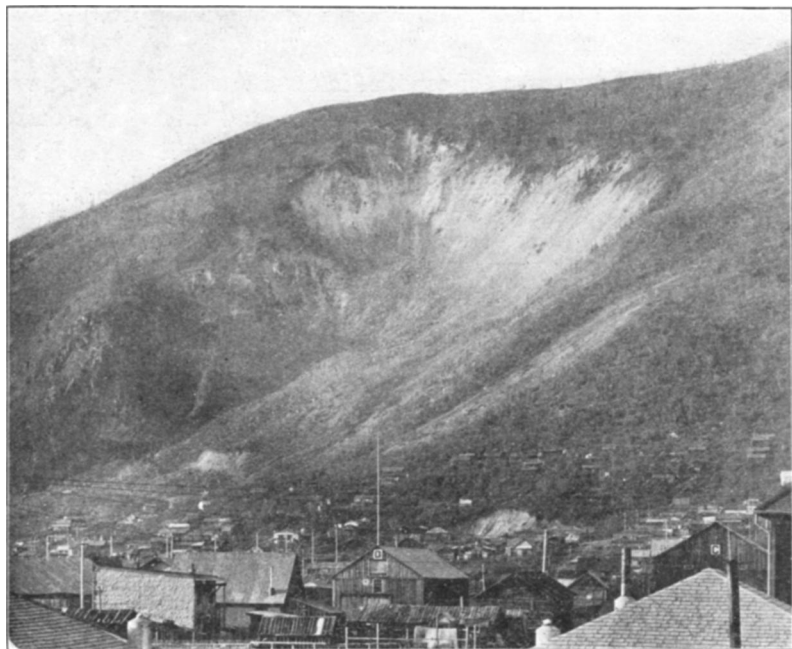


FIG. 1.—The Slide at Dawson.

The conditions which would seem to have combined to produce this naked scarp and the wide-spreading talus of broken rock at its base are somewhat as follows:

The general surface of the Yukon Territory in the vicinity of Dawson is permanently frozen for a depth of from 100 to 200 feet, beneath which the rock is more or less thoroughly saturated with water. In some places, and often on hillsides, this underlying water forms channels for itself through the frozen rock and soil, and breaks out as springs, and at the foot of Moosehide Mountain, directly

beneath the *slide*, one of these springs issues from the fractured serpentine. In the early days of the city this spring furnished the best supply of water for drinking purposes available in the vicinity.

During the summer season the water from this spring flows freely from the rock and down through the talus slope at the foot of the hill, but in winter, when the thermometer often drops to 50 below zero,

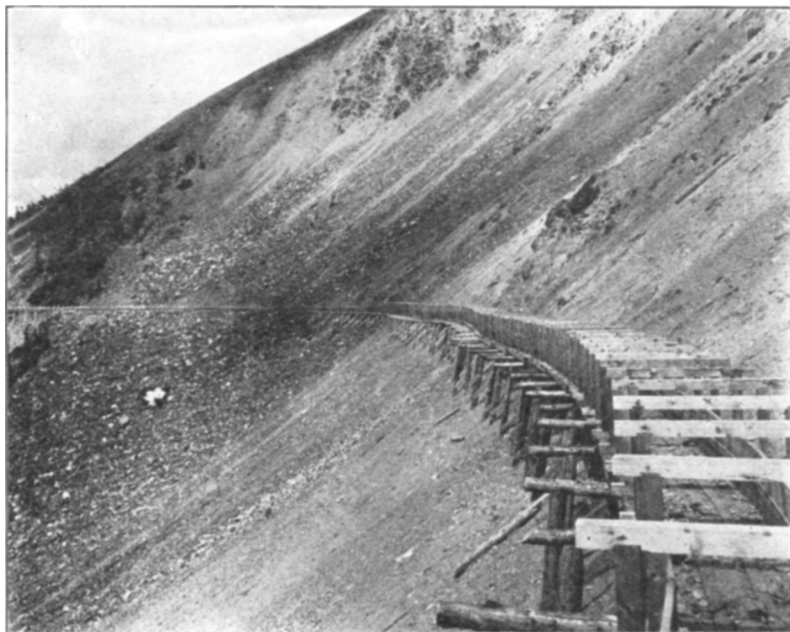


FIG. 2.—Upper part of the Slide at Dawson.

or lower, it freezes as it issues from the rock, or as it courses through the loose rock of the talus heap, and imbeds the broken fragments of rock in a matrix of clear, solid ice. At the same time loose pieces of rock are being constantly detached from the face of the hillside and dropped on this heap of rock-fragments lying below. In this way the heap of broken rock is being built up, and the weight of its higher side is being constantly increased. On account of this increase in weight, and also on account of the filling of the interstices between the rock-fragments with ice, there is a constant tendency for the pile of

loose rocks and ice to move downward and outward, and this tendency is increased in the spring and summer when the upper portion of the icy matrix becomes melted, so that the stones which were imbedded in it become loosened and slide downward over each other. This process of the breaking-down of the face of the almost vertical cliff and the growth and extension of the talus is constantly in operation year after year, so that the face of this hill of light-green serpentine always has the appearance of having just been freshly broken and the material at its foot of having just slid from it, while the sloping field of loose rock below shows abundant evidence of having been recently moved to its present position.

We have here simply a northern modification of the conditions found on many hillsides where springs give rise to broken slopes.

In the *Journal of Geology*, XII (1904), 232, I described some springs which flow from the frozen hillsides in the Klondike and which in winter issue into the cold air, and are then almost immediately frozen into ice. During the course of the winter, these masses of ice may assume considerable proportions, and when they form on the roads or main lines of travel, they are often, on account of their smooth, sloping surfaces, the occasion of much inconvenience to the freighters and stage-drivers. In several instances they have also been known to break up in the floors of houses, and to fill the house with ice, just as they fill the spaces between the loose rocks in the heaps of talus. These frozen masses of spring water are, in the Klondike, locally known as "glaciers," but as this word was already fully pre-occupied, I called them, on the suggestion of Professor T. C. Chamberlin, *chrystocrenes*.

The spring at the foot of Moosehide Mountain in Dawson forms one of these chrystocrenes, but instead of the water flowing out freely into the air, it flows into a detrital mass of broken rock and assists in gradually moving this rock outward from the foot of the mountain toward the Yukon River, which flows at its base.

I would suggest that the "rock glaciers" described by Mr. Capps may probably have been formed in the same way as the Slide at Dawson; that they are kept supplied with water flowing from springs in the sides of the hills; that this water becomes frozen into a mass of ice during the severe cold weather of winter; and that the ice, with

its contained fragments of rock, not only moves outward from the hills or mountains and down the valleys, but that when the upper parts of the ice melt under the influence of the warm weather in the spring, the rocks which were contained in it slide downward and form the concentric ridges which are so well shown in one of Mr. Capps's photographs.

The clear ice which constitutes the matrix for the mass of ice and stones in the talus is certainly not formed by the freezing of water during the warm weather of summer, when surface water is abundant, when streams are flowing in all the valleys, and when the temperature of the air often rises to 70° or even 80° F. It is equally certain that this icy matrix is formed during the winter, when, in the Klondike district, as well as in the interior of Alaska, the surface drainage is completely arrested, and the small streams are frozen to the bottom, and when the only water which reaches the surface is derived from springs with moderately deep-seated sources, though this spring water is quickly frozen into ice when it comes within the influence of the extremely low temperature of the overlying atmosphere.

The positions of these springs may readily be determined in winter time by the presence of chrystocrenes, which form more or less conspicuous mounds of ice elevated above the general snowy surface, but in the summer they are often very difficult to detect, for it may be impossible to distinguish between water derived from springs and that from surface drainage.

Therefore, the presence of the springs, and their possible significance in supplying ice to the talus heaps in order to enable these to move downward and outward more easily, would probably escape notice if investigations had been conducted exclusively in summer. Investigations conducted during the winter would probably prove the existence of springs behind these "rock glaciers," in which case they might be considered as chrystocrenes filled with broken fragments of rock.